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The Beginnings of Research in

SPACE BIOLOGY

at the

AIR FORCE MISSILE DEVELOPMENT CENTER

Holloman Air Force Base, New Mexico

1946 - 1952

HISTORICAL BRANCH
OFFICE OF INFORMATION SERVICES
AIR FORCE MISSILE DEVELOPMENT CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE

FOREWORD

On 24 August 1957, Lieutenant General Samuel E. Anderson, Commander of the Air Research and Development Command of the United States Air Force, pinned a Distinguished Flying Cross upon the uniform of Doctor (Major) David G. Simons. For Simons, Chief of the Space Biology Branch of the Aeromedical Field Laboratory at the Air Force Missile Development Center, the award for personal heroism and outstanding scientific accomplishment represented recognition for progress in a program initiated at the New Mexican scientific and engineering installation more than ten years before. For Anderson and other responsible officials of both the Command and the Center, the presentation of the coveted medal documented victory in another phase of man's efforts to explore the limitless reaches of the vertical frontier and to perfect a human capability for operating within interplanetary space beyond the earth's atmosphere.

This ceremony of decoration stimulated an awareness of the desirability of examining the history of Air Force participation in space biology research. A serious study of the origins

of such projects, their gradual evolution within an environment often indifferent or even hostile, and their scientific and technological contributions would be of considerable value in avoiding old mistakes or the duplication of previous effort, and for suggesting new paths of endeavor in the planning and pursuit of the more complex programs required in the immediate future.

As a first installment toward fulfilling this need, the present study is limited to an examination of the early beginnings of space biology research at what has since become the Air Force Missile Development Center--from 1946 until 1952. This is the period when the first such biological experiments of this program were attempted, when even rudimentary techniques for placing these experiments into the proper environment by means of balloons and rockets had to be devised, and when the program received its direction from a laboratory far distant from the scene, a laboratory in which an infant program of space biology could receive only a small amount of attention and possibly a smaller percentage of available research funds. The dawn of the second major period--when space biology research becomes part of the mission of the then newly created Holloman Air Development Center--brings to a close this early portion

of the history of space biology research at the Air Force Missile Development Center.

The following account is a product of the historiographical research of Dr. David Bushnell of the Air Force Missile Development Center's Historical Office. It has been prepared as part of a larger history by Dr. Bushnell of aeromedical research at Holloman which will soon be published in its entirety. Although the staff of the Aeromedical Field Laboratory has cooperated fully in making available their records and in patiently responding to frequent interrogation, responsibility in this study for conclusions--unless otherwise cited--and for all error is that of the Historical Office.

James Stephen Hanrahan
Center Historian
January 1958

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ORIGINS OF SPACE BIOLOGY RESEARCH AT HOLLOMAN

1946 - 1952

The Man-High balloon flights of 1957--the second of which on 19-20 August carried Major David G. Simons aloft for more than thirty-two hours and to a space-equivalent height of over 100,000 feet--dramatically emphasize the varied mission performed by the Air Force Missile Development Center. All projects at this Center are related in some way to progress in the field of guided missiles and space vehicles, but by no means are all concerned with the actual development and testing of such objects. Project Man-High, for example, was designed and sponsored by the Center's Aeromedical Field Laboratory to explore the high-altitude environment in which men, missiles and high-performance aircraft will operate, rather than to test missiles themselves. Moreover, Man-High was not an isolated project but was the culmination of a history of investigations of physical and biophysical conditions of the extreme upper atmosphere and the borders of space which began at Holloman Air Force Base more than ten years before.

In the beginning, and in fact for a number of years, Holloman's function in aeromedical and related activities was primarily to render support services. The first instances of such support were in connection with the firing of V-2 rockets at nearby White Sands Proving Ground starting in 1946, even before the Air Force guided missile program was brought to Holloman. Not all V-2's fired at White Sands carried experiments of interest to aeromedical research, but many of them did for a variety of both governmental and academic organizations.[1]

Virtually all V-2 firings required some support from Holloman. This might consist of little more than providing a landing strip for aircraft carrying project people who would prepare the actual experiments or for the planeloads of high officials and other important visitors who would arrive to watch the final blast. Upon occasion, however, Holloman was called upon to lend laboratory facilities as well as vehicular support and housing for visitors. Such services were quite apart from the sharing of resources in routine day-to-day operations such as range management that has always existed between the Air Force Missile Development Center and White Sands Proving Ground without regard to the needs of specific projects.[2]

Space biology research began to expand as a field of practical interest shortly after the end of World War II. An early example of a biological experiment elevated to the extreme upper limits of the atmosphere was the exposure of fungus spores to cosmic radiation on the flight of 17 December 1946. This experiment was sponsored by the National Institutes of Health, and ended in failure since the lucite cylinders containing the spores were not recovered.[3] Experimentation techniques improved, however, and in the following year a container of fruit flies carried to an altitude of 106 miles was successfully parachuted back to earth where the flies were recovered alive and in apparent good health.[4] Still other examples of early experimentation could be cited.

The experiments with most direct bearing upon later activities of Holloman's Aeromedical Field Laboratory, however, were those sponsored by the Aero Medical Laboratory* at Wright-Patterson Air Force Base which sent live animals into

*The laboratory at Wright-Patterson Air Force Base employs the term aeromedical as two words in its title. Because of this the laboratory complex at Holloman is sometimes called the Aero Medical Field Laboratory, although responsible officials at the New Mexican installation use the gramatically preferred name Aeromedical Field Laboratory.

the upper atmosphere above the New Mexican desert. The laboratory at Wright Field was the parent organization of the laboratory now part of the Air Force Missile Development Center, and many of the Wright Field aeromedical officers and civilian scientists involved in the V-2 research flights have also played a role in the origin and development of the Holloman unit. Similarly, the experiments themselves laid the groundwork for some of the space biology research accomplished later at Holloman Air Force Base.

The objective of the Aero Medical Laboratory's animal experiments at White Sands was clearly stated by the same David G. Simons, then a captain at the Wright Field establishment, who was the project engineer until after the second V-2 launching of the series:[5]

> Today there is no place on the earth's surface more than 40 hours travel from any other place so the question of the feasibility of travel beyond the reaches of the atmosphere inevitably arises. But what are the problems of space flight in a rocket? By theorizing, the various possible dangers and limiting factors can be appraised and appropriate means of protection against each surmised. However, only by actually performing the experiment can one prove or disprove the validity of the hypothesis, learn better ways of protecting against known hazards and realize for the first time, the existence of unsuspected dangers. Only the recovery of a live

animal showing no demonstrable ill effects will permit the claim that no major difficulty has been overlooked.

Captain Simons, who had been a space-flight enthusiast since childhood,[6] implicitly revealed in this statement his ambition to rocket through space some day himself. Unfortunately, the live animal recovery he was hoping for was not effected on any of the five biological flights carried out at White Sands. These experiments did contribute importantly toward developing the techniques which produced live recoveries later, however, and valuable physiological data were recorded.

Never did the Aero Medical Laboratory have the luxury of a V-2 rocket all to itself. The Air Force Cambridge Research Center, however, offered some space in the "Blossom" series of V-2's which had been assigned to it, and the Laboratory was delighted to accept. Overall responsibility for aeromedical participation was assigned to Dr. James P. Henry, head of the Acceleration Unit of the Biophysics Branch, Aero Medical Laboratory, and a strong supporter of research in all biophysical problems likely to be faced at extremely high altitude. Working closely with Captain Simons and others at Wright Field, Dr. Henry set to work devising methods for conveying a small

monkey to the upper limits of the earth's atmosphere in a V-2. Some sort of pressurized capsule to go inside the nose cone of the rocket was obviously needed, but the available space was extremely limited and there were few precedents to go by. The outside environment against which the capsule was to afford protection was one that no mammal had yet penetrated.[7]

Nevertheless, the capsule was made and the scene of operations shifted to New Mexico for the final preparations. Early in the morning of 18 June 1948 a nine-pound anaesthetized rhesus monkey was sealed inside the capsule, which in turn was placed in the nose of a V-2 rocket. Because the monkey's name was Albert the entire operation became known as the Albert (I) Project.

Unfortunately, the project was plagued with a whole series of operational failures. The apparatus for transmitting respiratory movements failed even before the time of launch. This probably made no real difference, though, because there are indications that Albert died as a result of breathing difficulties in the cramped capsule before his rocket left the ground. Even the parachute recovery system devised to lower the nose cone with its animal capsule back to earth failed to function properly,

and Albert would have been killed upon impact even if he had not died previously. The recorder placed within the capsule was successfully recovered and it showed no evidence of physiological activity at any time during the flight--which could mean either that the animal was dead from the outset or that there had been a complete failure not only of the mechanism for recording respiration but also of the electrocardiographic apparatus that was also attached to the subject.

The net result of the first Albert project, then, was experience for the scientists who had taken part in it and the incentive to do better next time. This they succeeded in doing. For the second experiment, which took place a year later on 14 June 1949, the capsule was redesigned to let the subject (Albert II) assume a less cramped position. The instrumentation was also improved, and so was the parachute recovery system. The latter still was not improved enough, however, and Albert II died at impact, but respiratory and cardiological data were successfully recorded up to that moment.

Thus it was established that a monkey had lived during an entire flight which reached an altitude approximately eighty-three miles above the surface of the earth. The evolution of

engineering techniques was making possible greater success in the scientific exploration of physiological factors related to space flight. Although not necessarily a direct cause of this greater success, the fact is that Holloman's participation was also greater in the second Albert experiment than in the first. For the first experiment Holloman provided a landing field for visiting aircraft and a certain amount of vehicular support. For the second experiment Holloman provided all this and laboratory space besides. The final preparation of the nose cone took place at Holloman rather than at White Sands Proving Ground.[8]

The third V-2 animal experiment was marred by unsatisfactory rocket performance and journeyed vertically only a few miles, but the fourth again reached the desired altitude. It followed a pattern identical with that of the second experiment; the successful recording of data from a living primate throughout the flight with parachute failure causing death at impact. In neither case did the heart and respiratory data recorded give any sign of "gross disturbance" as a result of rocket flight nearly to the limits of the earth's atmosphere.

To be sure, it had not been expected that during the few minutes' exposure such as during the V-2 experiments there

would be evidence of damage from cosmic radiation. Even if harmful effects from cosmic rays did occur they would presumably have been detected by careful examination afterward, and this was impossible because of failure to recover the animals alive.

Neither were the forces of acceleration and deceleration during the flights of an order expected to cause injury. On the second flight, for instance, the peak g-forces were 5.5, only five and a half times the normal effect of gracity, during rocket motor acceleration, and twelve or thirteen g's at the opening shock of the parachute recovery system (which later failed). It has since been established that these figures are well within the tolerance limits of a properly secured subject.

There remained the possibility of harm to the subject from the period of subgravity and actual zero-gravity (weightlessness) experienced between rocket burnout and return to a point where atmospheric resistance again became appreciable. Even though exposure during a V-2 test was brief, any ill effects of a subgravity state would be expected to appear at the time of flight. When none in fact appeared it was logical to conclude, at least tentatively, that a brief subgravity trajectory offered no major physiological hazards.

In order to explore subgravity effects more fully, the fifth and final V-2 experiment of the Aero Medical Laboratory introduced a new procedure. This time, in the summer of 1950, a mouse was used as the subject instead of a monkey and no attempt was made to record heart action or breathing. Unlike the monkeys, the mouse was not even anaesthetized because the purpose of the experiment was to record the conscious reactions of an animal to changing gravity conditions. For this purpose the mouse capsule was equipped with a camera system to photograph the mouse at fixed intervals.

As usual, the recovery system failed--the mouse did not survive the impact. But the photographs came through successfully and showed that the mouse retained "normal muscular coordination" throughout the period of subgravity, even though "he no longer had a preference for any particular direction, and was as much at ease when inverted as when upright relative to the control starting position."[10]

Even before this last V-2 blasted off toward space, scientists of the Aero Medical Laboratory were making plans to continue their experiments using the newly-developed Aerobee high-altitude rocket, which was specifically designed for research purposes. Although the test program was still to be

directed from laboratory headquarters at Wright Field, launch operations and much other activity now shifted wholly to Holloman, where the Air Force missile program had started to prepare an Aerobee test facility as early as 1948.

The first Aerobee did not streak skyward from Holloman until December 1949, however, and the first aeromedical Aerobee did not get off until 18 April 1951. When it finally went it carried an experiment basically similar to those of the first aeromedical V-2's--a monkey fully instrumented to record breathing and heart rates. And the result was familiar also; physiological data successfully recorded, no sign of "gross disturbance" in the subject--and the parachute failed again.[11]

Finally, when the second aeromedical Aerobee was fired 20 September 1951, the long-awaited breakthrough in parachute recovery was successfully accomplished. This vehicle carried an arkful of animals to an altitude of 236,000 feet and brought them all back alive. Included in the menagerie were a monkey instrumented to record heart beat, respiration and blood pressure; nine mice who went along simply to be exposed to cosmic radiation; and two other mice in a rotating drum for the photographic observation of their reactions to subgravity.

Two hours after impact the monkey died, but data recorded during flight as well as the later autopsy suggested that death was not the result of any ill effects of the flight but rather of landing shock or heat prostration, or both of these. There had been a slight delay in retrieving and opening the capsule after it was successfully parachuted down and the monkey's small compartment became much too hot in the midday sun of southern New Mexico. Two of the eleven mice also died following recovery but none showed any apparent ill effects from cosmic radiation.

In the subgravity experiment, one of the two mice in the rotating drum had undergone a prior operation removing the vestibular apparatus that gives mammals a sense of equilibrium. He was already accustomed to orient himself by vision and touch exclusively and did not seem affected by loss of gravity during the flight. He had no trouble holding on to a small projection in the side of the drum. The other mouse, which was normal, clawed at the air and appeared definitely disturbed during the subgravity phase of the trajectory.[12]

The third and last aeromedical Aerobee, fired 21 May 1952, was still more successful. Not only were all passengers--two

mice and two monkeys--brought back alive from the upper atmosphere, but they were also rescued in time from the New Mexico sun. This time both mice were normal, and again they were placed in a rotating drum. One had a paddle to cling to and one did not, and the photographs taken in flight showed that "if given the opportunity to use his tactile sense and cling to something, an animal will remain oriented and quiet" during exposure to subgravity. The mouse with nothing to cling to showed some signs of temporary disorientation during the interval of complete weightlessness, although that interval was too short to permit any firm conclusions.

As for the two monkeys, they were arranged in contrasting positions, one seated upright and the other supine, and the recorded physiological data indicated that neither suffered any harm. Their trip was distinguished merely by the fact that they were the first primates to reach the extreme upper atmosphere--thirty-six miles to be exact--and survive. Both were presented to the National Zoological Park of the Smithsonian Institution in Washington, D.C., where one subsequently died from causes unrelated to rocket flight and the other is still alive and healthy.[14]

It is interesting to note that the V-2 and Aerobee aeromedical flights aroused strong complaints from certain animal lovers in the United States and abroad, but the flights also inspired a surprising number of human volunteers to write and offer themselves as passengers in the next rocket. Such offers have come to Holloman from as far away as the Philippines. Often, although not invariably, they have been made by persons hoping to pay some debt to society by gathering scientific information at considerable risk and inconvenience to themselves. One offer, in fact, was submitted in November 1956 by a resident in the Washington State Penitentiary.[15]

On the whole, the development of rocketry techniques between 1946 and mid-1952, including the perfection of vehicle recovery systems, was important in the evolution of space biology as a field of practical research. These engineering successes had permitted significant scientific accomplishment during these early years in cosmic radiation, subgravity phenomena and other areas of interest. V-2's and Aerobees, however, were only two methods of lofting biological and other experiments to the borders of interplanetary space, as other developments at Holloman during these same years will indicate.

The first completely successful high-altitude animal flight at Holloman Air Force Base was not one of the Aerobee rocket firings. The honor goes instead to a balloon that carried eight white mice to 97,000 feet on 28 September 1950. This achievement formed part of still another research venture of the Wright Field Aero Medical Laboratory and, like the Aerobee flights, was conducted under the general auspices of Project MX-1450R, Physiology of Rocket Flight.[16]

The Aerobee flights were primarily concerned with exploring subgravity conditions and only incidentally carried cosmic radiation experiments. The September balloon flight and other balloon experiments in the same series were primarily intended to determine the effects of cosmic rays upon biological specimens. The use of balloons did not conflict with the term "Rocket Flight" as found in the project title because one of the environmental factors on which data would be needed whenever long-range manned rockets became available was obviously the effect of cosmic radiation upon passengers and crew. For the moment no rocket was capable of staying at high altitude long enough to expose living subjects to such rays for more than a few minutes, and for radiation studies this was not enough.

Balloons, on the other hand, could maintain high altitudes for prolonged periods and obtain required research data at very low cost--thanks in large part to improvements in balloon manufacture and balloon techniques that occurred since World War II.

The basic innovation was the introduction of balloons made of polyethylene, a plastic material between one- and two-thousands of an inch thick and very strong. Plastic stratosphere balloons were pioneered chiefly by Mr. Otto C. Winzen of Minneapolis, who helped organize the aeronautical laboratories of General Mills, and who formed Winzen Research, Incorporated, his own concern, in 1948. Unlike rubber-type balloons, these did not expand as they rose. Or, to be exact, the plastic material was nonextensible and the cell was filled with gas to only a fraction of its capacity at launch, the gas expanding as the balloon climbed through lesser pressures until it entirely filled the capacity of the balloon at ceiling altitude. Such balloons were much more stable, permitting long-duration, constant-level flights and better control. They could carry far greater payloads, which was an obvious advantage for research purposes. And they even brought an extra touch of romance to

space biology, since the plastic surfaces, glistening in the sun, led to frequent confusion with flying saucers.[17]

Furthermore, much of the post-war development in balloon research had actually taken place at Holloman Air Force Base, which was therefore well qualified to handle the series of aero-medical flights. Holloman's first polyethylene research balloon was launched 3 July 1947 by a New York University research team. This was twenty days before the historic first of Holloman's missiles climbed high over the vast test range.[18]

From this first Holloman balloon launch until August 1950, numerous research flights were undertaken at Holloman obtaining physical data on the upper atmosphere in support of a wide variety of projects. Some of these balloon-transported experiments, notably those exposing cosmic ray track plates to high-altitude radiation, contributed to the research groundwork for the later biological experiments, but apparently none were designed expressly for biophysical research. Also, part of this early balloon activity used old-style extensible balloons made of rubber or similar material. Yet every flight, regardless of research objectives or balloon material, contributed in some way to build up a remarkable launch and recovery capability

at Holloman. These operations in the beginning had depended to a large extent upon visiting technicians and borrowed equipment. By 1950, however, the base had its own organized Balloon Unit and offered efficient launch and recovery services for both local and off-base projects.[19]

The first of the balloon flights launched for the Aero Medical Laboratory took place 29 August 1950, a month before the record-making mouse flight. It was strictly for practice, carried no animal subjects and, like all subsequent aeromedical flights, used a polyethylene plastic vehicle. It was launched at 0530 from the picnic area of White Sands National Monument, soared to an altitude of between five hundred and a thousand feet and then descended ingloriously about half a mile from the launch site. A second practice flight later that day reached 67,000 feet and was judged successful. It was followed by the first attempted animal flight, on 8 September, which was unsuccessful; the balloon reached only 47,000 feet and all "14 or 16" mouse subjects were dead when recovered as a result of capsule leakage and depressurization. The fourth flight, 16 September, carried equipment only, but the fifth flight was the one on 28 September that took eight mice to 97,000 feet. One

of the mice died en route back to the base after landing, but autopsy indicated that the death was due to pulmonary inflammation rather than to cosmic rays or events of the flight.[20]

Between 28 September 1950 and the end of 1952 the Balloon Unit launched twenty-one more aeromedical balloon flights. These were coming to be regarded as a regular Holloman activity even though the direction of the program remained under the ultimate direction of the Aero Medical Laboratory, and of Dr. Henry, in particular, who was the same individual that had directed the first V-2 animal flights.

Some balloon flights carried nonbiological payloads such as cosmic ray track plates and experimental equipment, and the animal tests now progressed from mice to hamsters, cats and dogs--even fruit flies being represented. The usual flight plans called for altitudes in the neighborhood of 90,000 to 100,000 feet with durations gradually increasing until they reached twenty-eight hours. To be sure, full specifications were not always met since roughly half the flights experienced either balloon failure (complete or partial) or some other type of equipment trouble. In still other cases balloon and equipment functioned properly but recovery of the flight capsule was delayed too long for the test subjects to remain alive. In fact, out

of eleven flights in all (including those of September 1950) that involved insect or animal subjects, only two could be counted as wholly successful, although others enjoyed partial triumphs. Such problems were inevitable in a young art like research ballooning, and above all in the aeromedical branch of that art which has always presented special complications.[21]

One complication shared with all other projects that required long-duration flights was the difficulty of maintaining ceiling altitude with a plastic balloon at night, due to the cooling and contraction of the gas. This could be overcome by dropping ballast, but the operation was not easy. A complication present only in aeromedical flights was the need to provide a controlled environment for biological specimens. This required careful balancing of a great many factors. For instance, by adding more animals to a capsule it was possible to reduce or even eliminate the need for artificial heating at night, but only at the cost of increasing the requirements for oxygen supply and day-time cooling. Atmospheric controls also involved apparatus whose bulk and weight had to be taken into account when planning a flight. Last but certainly not least, animal flights required unusual precision in recovery in order

to bring the specimens back alive. The fate of the monkey on the second aeromedical Aerobee showed what could sometimes happen with even a slight delay in reaching the capsule. Environment controls normally were not adequate both to protect the specimens in flight and to protect them for any considerable length of time after landing.[22]

People of the aeromedical projects and of the Holloman Balloon Unit were working hard to bring these and related problems under control, even though their work did not start to bear fruit on a very noticeable scale until the period from 1953 to the present--which is discussed in a later installment of the history of aeromedical research at the Air Force Missile Development Center. During this early period, the Balloon Unit brought to space biology flights the benefit of its continuing work with other projects. An interesting example is the so-called "covered wagon" launch method, which was devised at Holloman specifically for Project Moby Dick, an Air Force study of high-altitude wind fields. The covered wagon was a flat-bed trailer with high headboard and nylon top, in which a balloon could be protected from winds during inflation. Most research balloons today have outgrown the dimensions of a covered wagon launcher, but the method was used

successfully on several of the 1952 aeromedical flights with balloons 72.8 and 85 feet in diameter.[23]

Research ballooning at Holloman and elsewhere benefited further from the experimental work of organizations such as Winzen Research, Incorporated and General Mills--the two leading manufacturers of plastic balloons--and the University of Minnesota, which was engaged in a continuing effort to improve balloon performance under a contract from all three armed services.[24] Both New York University and the University of Minnesota designed animal capsules for use at Holloman, and a University of Minnesota faculty member, Dr. Berry Campbell, took part in the post-flight examination of test specimens under a separate Air Force contract.[25]

However, even when no operational difficulties arose, the aeromedical flights to and including those of 1952 did not produce much useful biological information. The animal subjects, if successfully recovered, showed no signs of radiation damage. But this fact in itself proved little since evidence was accumulating to the effect that no significant amount of cosmic radiation penetrates to the 90,000-100,000-foot level south of 55° north geomagnetic latitude,[26] and Holloman Air Force Base is

located at 41^{o} north. In technical terminology, flights at Holloman gave exposure to light primary particles and "stars" but to practically no multibillion-electron-volt heavy nuclear "thindowns." Therefore the early flights were important mainly for the additional experience they provided in the way of balloon techniques, and for developing "control" data that would help later in evaluating data obtained at higher latitudes.

There was at least one other project involving aeromedical research that made use of Holloman facilities during the period under consideration, although not necessarily related directly to space biology. A joint team representing both the Aero Medical Laboratory and the Equipment Laboratory at Wright Field came to Holloman in 1950 to test improvements in high-altitude escape procedure. They were especially interested in a device preset to open a parachute automatically after a flier falls to the level where there is sufficient oxygen to breathe. While they were in New Mexico one member of the team, Captain (now Major) Vincent Mazza, set a new record by dropping from an airplane at an altitude of 42,176 feet. Another volunteer in these tests, Master Sergeant (later Captain) Jay D. Smith was assigned to Holloman, rather than Wright Field.

Although the local base gave extensive support to the project, the principal project people were visitors to Holloman on temporary duty.[27]

The aeromedical Aerobee firings and the cosmic radiation balloon program both involved considerable temporary-duty travel between Holloman and the directing laboratory at Wright Field in Ohio. This system was proving impractical in certain respects, for the preparations for rocket and balloon flights were elaborate and time-consuming and required more or less permanent laboratory facilities. Although the balloon program obtained launch and recovery services from the facilities and people of the Holloman Balloon Unit, the space biology project officers also needed decent accommodations for hamsters and fruit flies which the standard base support organization was poorly equipped to offer.

For all these reasons it became necessary to create a special unit at Holloman--the Aeromedical Field Laboratory--under the original direction of Lieutenant James D. Telfer. This step was taken officially about the middle of 1951, and the first permanent building ever constructed expressly for use by the new unit appears to have been ready in October of that year.[28]

Lieutenant Telfer and other officials of the Aeromedical Field Laboratory were still technically assigned to the parent organization at Wright Field although they were present at Holloman on an indefinite basis. In practice Lieutenant Telfer, who was himself a geneticist, was delegated a large amount of independent responsibility in directing the balloon flights (although not the Aerobee firings). Another development of considerable significance later was the formal creation within Holloman's 6540th (later 6580th) Missile Test Group of an Aero-Medical Sub-Unit which was endowed with the specific function of providing a "small group of Holloman Air Force Base personnel to support [the] Aeromedical Field Laboratory."[29]

Gradually, the facilities and people for a significant program of space biology and other aspects of research related to human factors in rocket flight were accumulating at the installation which was later to evolve into the present Air Force Missile Development Center. The gathering of human and material resources, however, was only one of the important contributions of this early period. Equally important were the experience gained in rocket and balloon launching, instrumentation and recovery techniques, and the collection of a growing

body of scientific data related to cosmic radiation and subgravity problems which would prove very useful in later programs. In various manners the years 1946 through 1952 at Holloman marked the practical beginning of Air Force research in space biology.

NOTES

CHAPTER I — ORIGINS OF AEROMEDICAL RESEARCH AT HOLLOMAN:

1946–1952

1. Homer E. Newell, Jr., High Altitude Rocket Research (New York, 1953), pp. 30-33, offers a table of V-2 firings with a brief notation of the experiments carried in each case. To be sure, this table must not be taken literally when it attributes particular tests to Air Research and Development Command long before the command was created.

2. Concrete examples of Holloman-White Sands cooperation in general support and administrative functions are discussed in other publications of the Air Force Missile Development Center's Historical Branch. See especially Integration of the Holloman-White Sands Ranges, 1947-1952 (2nd edition, 1957), and History of Flight Support, Holloman Air Development Center, 1946-1957 (July 1957).

3. L. W. Fraser and E. H. Siegler, High Altitude Research Using the V-2 Rocket, March 1946 - April 1947 (Johns Hopkins University, Bumblebee Series Report No. 8, July 1948), p. 90.

4. Kenneth W. Gatland, Development of the Guided Missile (London and New York, 1952), p. 188.

5. Capt. David G. Simons, Use of V-2 Rocket to Convey Primate to Upper Atmosphere (Wright-Patterson Air Force Base, AF Technical Report 5821, May 1949), p. 1.

6. Cf. Scope Weekly, 3 October 1956, p. 7.

7. A popular account of the Aero Medical Laboratory's V-2 experiments is offered by Lloyd Mallan, _Men, Rockets, and Space Rats_ (New York, 1955), pp. 84-93. This should be read in conjunction with the technical paper by Captain Simons, cited in the above footnote, and the article by Dr. James P. Henry, _et al._, "Animal Studies of the Subgravity State during Rocket Flight," _Journal of Aviation Medicine_, Vol. 23, pp. 421-432 (October, 1952).

8. Interview, Maj. David G. Simons, Chief, Space Biology Branch, Aeromedical Field Laboratory, by Dr. David Bushnell, HADC Historian, 6 September 1957.

9. Simons, _Use of V-2 Rocket_, p. 22; interview, Maj. Simons by Dr. Bushnell, 13 December 1957.

10. Henry, _et al._, "Animal Studies of the Subgravity State," _loc. cit._, p. 428.

11. _Ibid._, p. 425.

12. _Ibid._, pp. 423, 424, 429-431; _Final Test Report, USAF Aerobee No. 19_, 19 February 1952; "Historical Report, Holloman Air Force Base... 1 September 1951-31 October 1951," pp. 104-107; Maj. David G. Simons, "Review of Biological Effects of Subgravity and Weightlessness," _Jet Propulsion_, May 1955, p. 211.

13. Henry, _et al._, "Animal Studies of the Subgravity State," _loc. cit._, p. 429.

14. _Ibid._, pp. 425, 429; Florence Clason, typed summary of Aerobee flights in Historical Branch files; _Alamogordo Daily News_, 1 December 1957; Maj. Simons, "Biological Effects of Subgravity," _Jet Propulsion_, May 1955, p. 211.

15. Lt. Col. (later Colonel) John P. Stapp, Chief, Aeromedical Field Laboratory, HADC, noted in September 1955 that an "indignant letter from a mouse-loving lady in England" arrived three years after the first publicity on the Aerobee flights (ltr., Lt. Col. Stapp to Otto C. Winzen, 21 September 1955). A typical human volunteer letter came from Ernesto S. Veloso, Cebu City, Philippine Republic, 21 January 1956, addressed to "U. S. Air Force Laboratory, Alamogordo, N. M." The letter was answered by Maj. Simons on 17 February 1956, respectfully declining this "very patriotic" offer on technical grounds. The offer from Washington State Penitentiary was addressed by an inmate on 27 November 1956 to Dr. Hubertus Strughold of the School of Aviation Medicine; Dr. Strughold referred it to Holloman, where it was duly answered by Maj. Simons on 10 January 1957.

16. "Historical Report, Holloman Air Force Base...1 September 1951-31 October 1951," p. 106; Maj. David G. Simons, Stratosphere Balloon Techniques for Exposing Living Specimens to Primary Cosmic Ray Particles (HADC Technical Report 54-16, November 1954), p. 11.

17. Simons, Stratosphere Balloon Techniques, p. 6 and passim; Winzen Research, Inc., "Rebirth of the Balloon" (Minneapolis, n.d.); interviews, Mr. Berhard D. Gildenberg, Chief, Technical Support Section, AFMDC Balloon Branch, by Dr. Bushnell, 18 and 30 September 1957.

18. The first research balloon flight of any sort at Holloman had been slightly earlier, 5 June 1947; this involved a cluster of rubber-type balloons (interview, Mr. Gildenberg by Dr. Bushnell, 18 September 1957).

19. The principal source of data on early balloon operations is the monthly section on "Electronic and Atmospheric Projects" in Progress Summary Report on U. S. A. F. Guided Missile Test Activities, which was published at Holloman on a monthly basis from 1 November 1947 to 1 July 1950 (and then continued for a while as a quarterly). Other data have been obtained from the interviews with Mr. Gildenberg already cited.

20. Simons, Stratosphere Balloon Techniques, pp. 11-12.

21. Ibid., pp. 12-19.

22. Ibid., pp. 1, 4-10, 51-59.

23. Ibid., 7, 18-19; "Historical Report, Holloman Air Force Base...1 September-31 October 1951," pp. 88-90; "Historical Report, Holloman Air Force Base...1 November-31 December 1951," pp. 82-86; interview, Mr. Gildenberg by Dr. Bushnell, 18 September 1957. The diameters cited refer, of course, to a balloon filled by expansion of the gas to its full capacity, as at ceiling altitude.

24. See Department of Physics, University of Minnesota, Progress Report on Research and Development in the Field of High Altitude Plastic Balloons, published in various installments.

25. Simons, Stratosphere Balloon Techniques, pp. 1, 5-6, 10, 56-57.

26. Ibid., pp. 1-2.

27. Rocketeer (HAFB), 29 September 1950; Capt. Vincent Mazza, "High Altitude Bailouts," Journal of Aviation Medicine, Vol. 22, pp. 403-407 (October 1951); Memorandum Report, High Altitude Bailouts, WADC, 1950.

28. *Holloman AFB Reference Book*, June 1952, p. 7; building data card on Building 1201, in Real Estate Section, Installations Division; interview, Maj. Simons by Dr. Bushnell, 13 December 1957; *Stratosphere Balloon Techniques*, p. 4. The Laboratory also had a second building, which was a wartime "temporary" structure converted to use as housing for animals (building data card on Building 1203).

29. Comptroller, HAFB, Organization and Functions, April 1952, p. 82; interview, Maj. Simons by Dr. Bushnell, 17 December 1957.

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